UNIT II

- Types of Power Plants
  - Hydroelectric
  - Steam
  - Combustion
- Power Plants in Maryland
  - Locating Power Plants
  - Power Plants and Fuel Types
- Electric Power – *From Power Plant to You!*

How is Electricity Produced?

How is Electricity Produced?
2.1 Types of Power Plants and Generation

Activity A: Hydro-Power Plant Model

Did you ever wonder how electricity is generated? In this activity you will explore the three types of power plants in Maryland. You will design and construct models that will demonstrate the way these plants generate electricity.

Materials:

7 – two liter soda bottles
Duct tape or waterproof cement
Meter stick
Permanent marker
Protractor
Scissors
Chair
Stop watch/wristwatch with second hand
½" Rubber tubing
¼" Rubber tubing
1 or 2 Buckets
Wood blocks
Water
Cork
Table

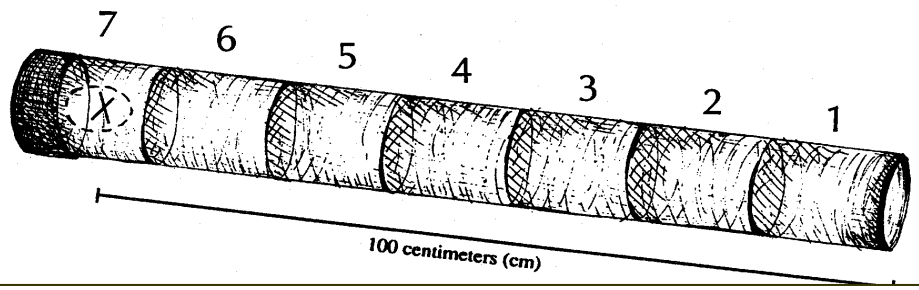
Procedure:

1. Cut both the bottom and top portions from six of the soda bottles. You *will then have six see through cylinders.*

2. Cut the top off from the seventh bottle, leaving the bottom. Cut an oval window about 6-8 cm wide in the side of the bottle.

3. Glue or tape the bottles together as shown in Figure 1.

Figure 1: Tunnel Construction



You will make a tunnel through which you will run water; so make sure the joints are watertight. Be sure to fit each successive bottle onto the outside (not the inside) of the bottle before it. Begin with the closed end of the bottle first.

4. Use the meter stick to measure 100 centimeters (cm) from the bottom, open end, back of the model. Use a permanent marker to make a large "X" on the inside of the top, closed bottle at the 100 cm mark; opposite the window cut in one side.

5. Set up the model as shown in Figure 2. Use the protractor and the wood blocks to set the model at a 5º slope.

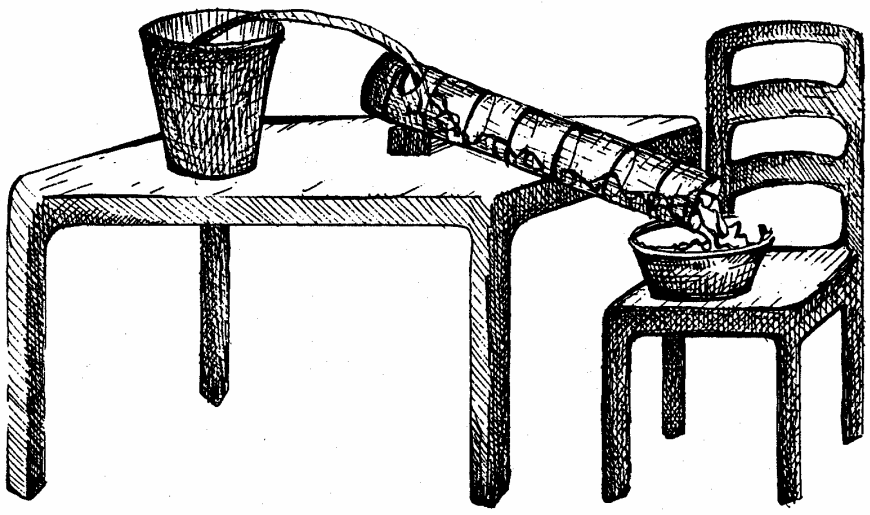


Figure 2: Model Diagram

6. Run water through the model using ¼" rubber tubing as a siphon. Drop a cork into the "stream" and time how long it will take to travel the marked 1 m distance. Perform three trials. Record the data in the table on the data sheet.

7. Repeat the process after changing the tubing to ½" diameter. Record the data.

8. Change the slope to 20º. Repeat steps 6 and 7. Record data.

9. Calculate the water speed by dividing the distance (cm) by time (sec).

Discussion:

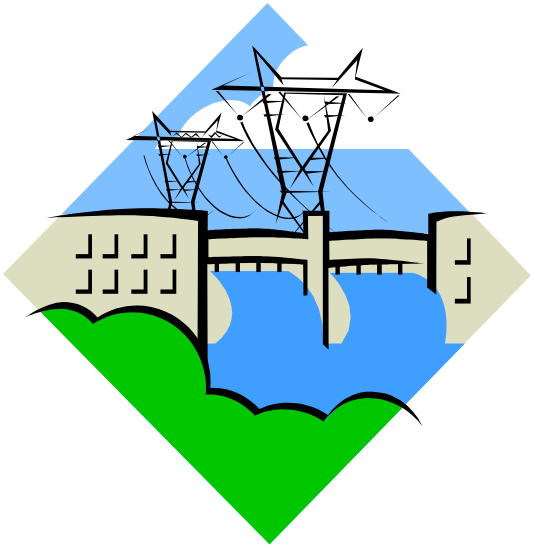
1. List differences in speed between a 5º slope and a 20º slope when using a low volume of water.

2. How do speeds change in high volume?

3. Using the information you have just collected in the experiment, draw a picture of how you think water is used as a power source to make electricity.

4. Hydroelectric power, the third major generation technology in Maryland, uses the energy of moving water to produce electricity. Potential energy in the form of stored water behind a dam is converted to kinetic energy when drawn by gravity through the dam's conduits.

   In this system, flowing water pushes against turbine blades to drive generators and produce electricity. Now that you know more about a typical Hydroelectric Power Plant, compare and contrast your diagram with the actual plant using a Venn Diagram, in activity 1A.



How is Electricity Produced?
2.1 Types of Power Plants and Generation

DATA TABLES: The Effect of Volume and Slope on Water Flow

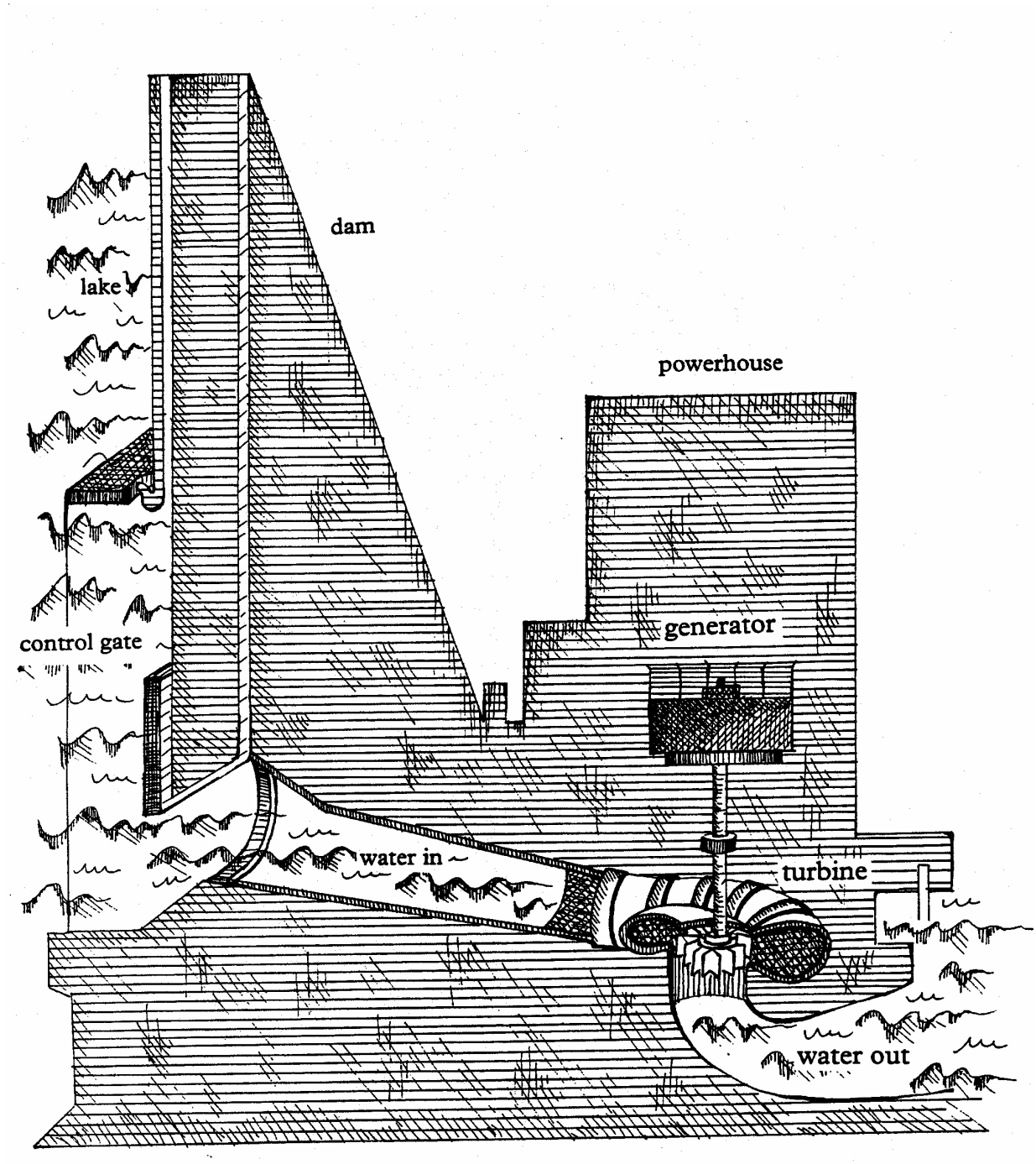
**Water Speed = Distance (cm) / Time (sec)*

Table A **Water Speed/Low Water Volume** **(1/4" Tubing)**			**Table B** **Water Speed/High Water Volume** **(1/2" Tubing)**		
Procedure	5ºSlope Time (sec)	20º Slope Time (sec)	Procedure	5ºSlope Time (sec)	20º Slope Time (sec)
Trial 1			**Trial 1**		
Trial 2			**Trial 2**		
Trial 3			**Trial 3**		
Average Time (sec)			**Average Time (sec)**		
Length of Model (Distance in cm)			**Length of Model (Distance in cm)**		
***Water Speed**			***Water Speed**		

Adapted from The Energy Sourcebook, Tennessee Valley Authority.

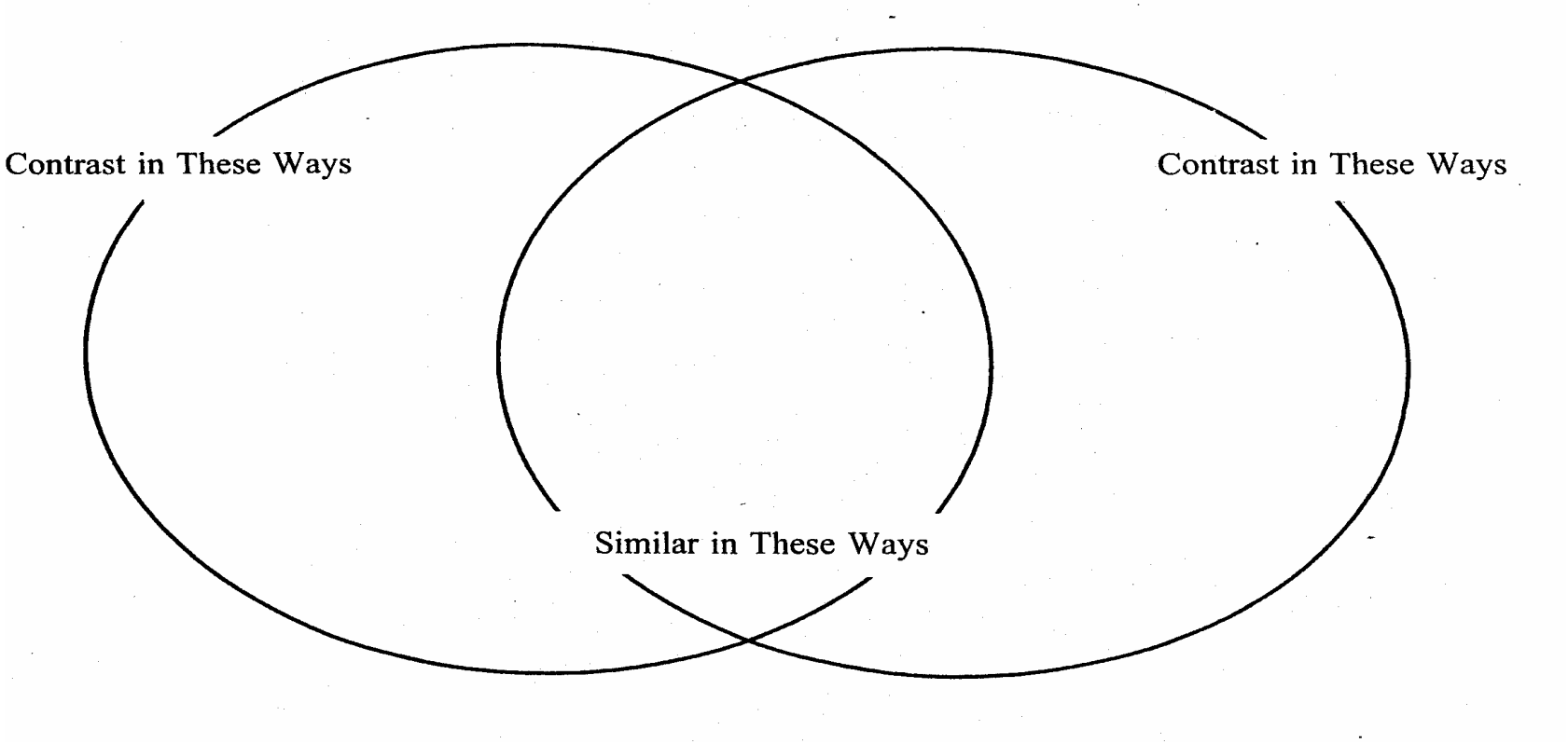
How is Electricity Produced?
2.1 Types of Power Plants and Generation

Hydroelectric Power Plant



How is Electricity Produced?
2.1 Types of Power Plants and Generation

Compare and Contrast Venn Diagram



How is Electricity Produced?
2.1 Types of Power Plants and Generation

Activity B: How is Steam Used to Generate Electricity?

You will be using the turbine that you made in a previous activity. Mark one of the blades with a magic marker to be used as an indicator. Before you begin, make a prediction of what will happen when a turbine is exposed to a jet of steam.

Prediction:

Materials:

Flash with stopper and tubing	Turbine (from previous activity)
Heat source (hot plate)	Magic Marker

Procedure:

1. Place your turbine next to the jet of steam that is supplied by your teacher.

Warning: *The jet of steam is extremely hot and the blades could be sharp!!*

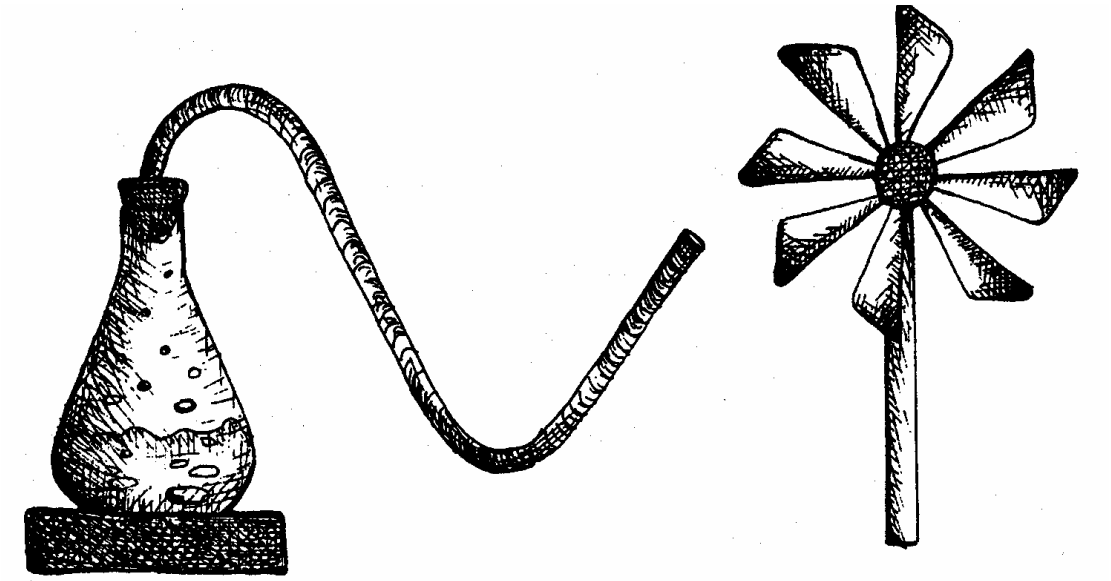


Figure 1: Experiment Construction

2. Count the number of revolutions per minute (rpm) on your turbine wheel and record your data in the table provided. *A revolution is one complete spin of your turbine wheel.*

3. Think of a way to modify your turbine to increase its revolutions per minute. Make the change.

4. Retest and record your data in the table provided.

Types of Power Plants and Generation

DATA TABLE		
Trial	**RPM**	**Modification Used**
1		**None**
2		
3		

Steam turbine power plants are the most common generation technology in Maryland. A steam turbine is an enclosed rotary device in which the energy of high-temperature, high-pressure steam is converted to mechanical energy by passing through rows of radial blades attached to a central rotor. The rotational motion caused by the steam is used to power the generator to produce electricity.

Steam turbine plants in Maryland use fossil fuels (coal, oil, natural gas), municipal solid waste, wood, or nuclear fission to generate steam. The warm water and steam are cooled in large towers called condensers. Steam electric stations in Maryland burn mostly pulverized coal, reflecting the national trend during the 1970's and 1980's toward coal and away from oil as the primary fuel.

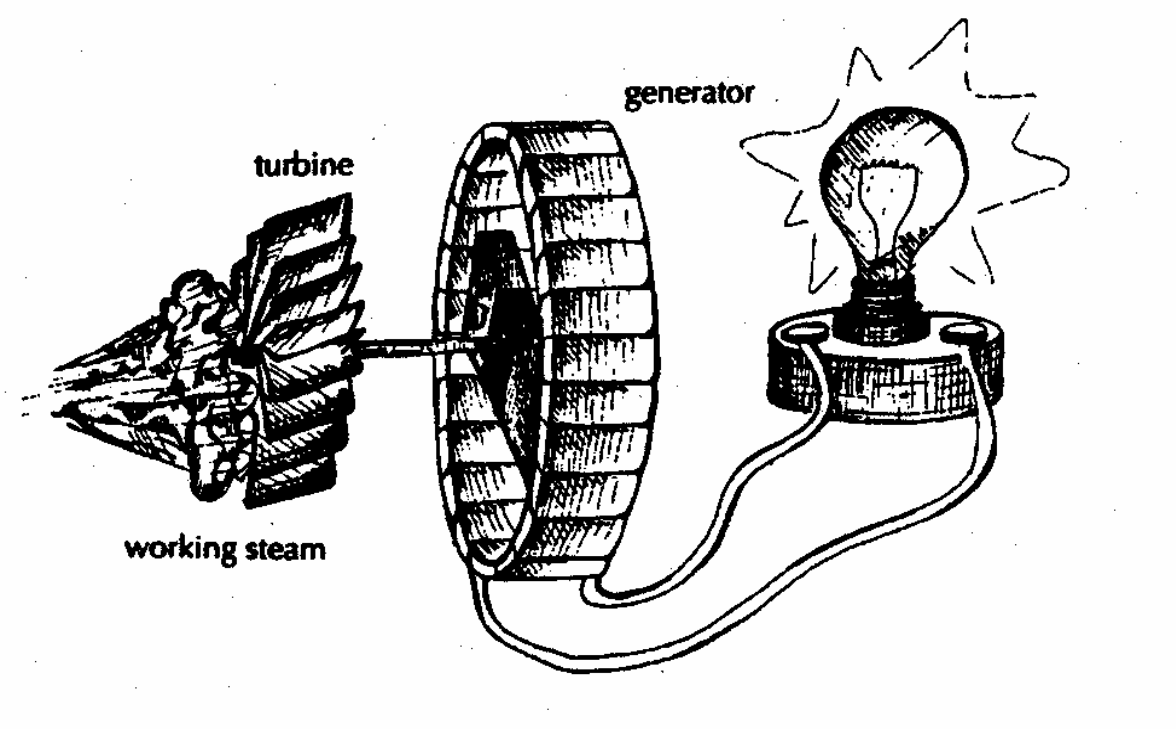
Discussion:

1. From your turbine experiment, describe what part represents the turbine. Why?

2. From your turbine experiment, describe what part represents the boiler. Why?

3. Instead of a hot plate that was used by your teacher to produce steam, list several fuels a steam turbine power plant could use to generate heat and produce steam.

4. Research the reasons why power plants used more coal and less oil as the primary fuel for generating electricity during the 1970's and 1980's.



How is Electricity Produced?
2.1 Types of Power Plants and Generation

Activity C: A Combustion Turbine

Procedure:

The third method of producing electricity is by means of a combustion turbine. Read the following article describing how electricity is produced from a combustion turbine. Label the sequence chain organizer to help you understand this process.

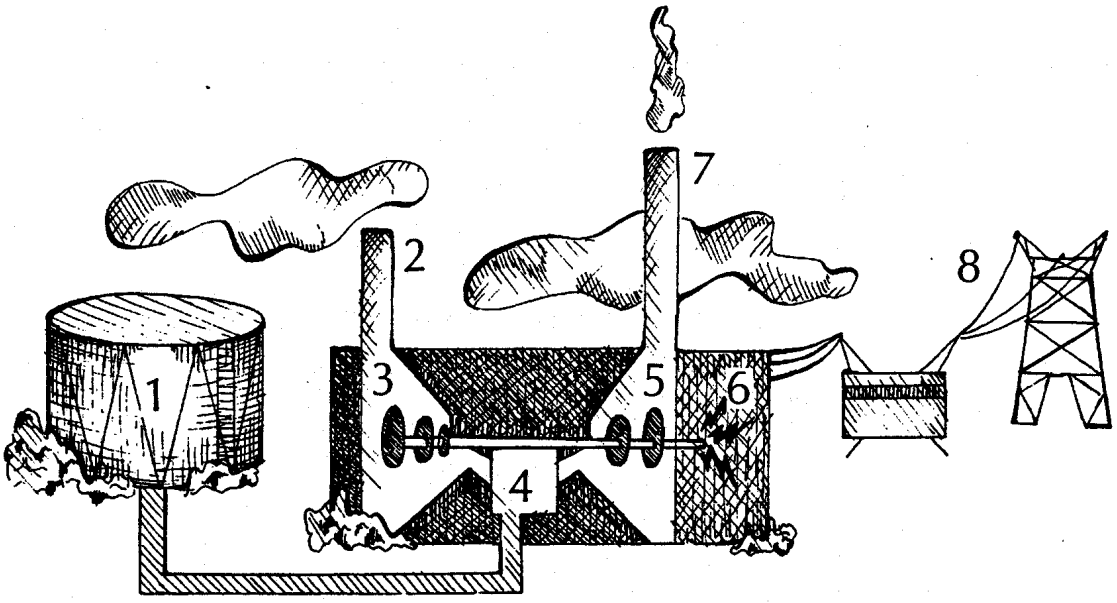


Figure 1: Sketch of Electricity Generation from a Combustion Turbine

A combustion turbine that burns natural gas, kerosene or low-sulfur, household type oil is delivered by truck or barge and stored in a tank (1). Air drawn from the outside (2) is compressed (3) and discharged into combustion chambers (4) where fuel is added, mixed with air and burned. The burning process produces high-pressure combustion gases that flow to the turbine (5). Pressure of the gases rotates the turbine turning an electric generator (6). After

passing through the turbine, gases are exhausted to the outside (7). To keep sound levels as low as those of the surrounding area, extensive silencing equipment is installed for the entire turbine, including the air intake and exhaust outlet. Electricity flows to your home through the transmission lines (8).

Combustion turbines provide immediate power for peak demands. They can be started quickly and reach full capacity in a matter of minutes. Combustion turbines supply start-up power for steam plants in an emergency. They can be started and operated without an external source of electricity. Combustion turbines are not designed to operate continuously for long periods of time, so their use is limited to times when demand for electricity is greatest. High operating and maintenance costs also limit the use of combustion turbines to short periods.

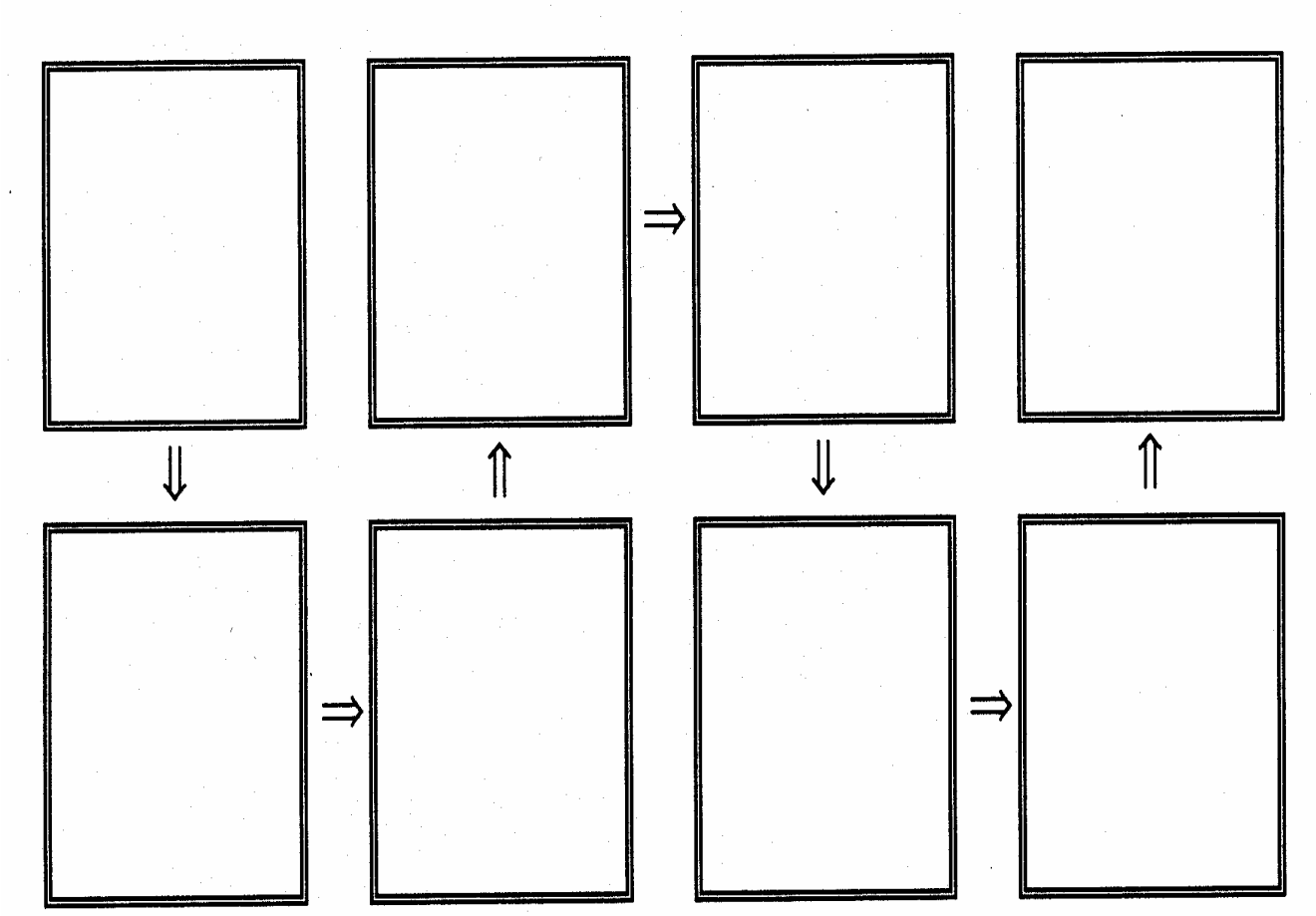


Figure 2: Sequence Chain

Discussion:

1. After reading and examining a combustion turbine, list two ways this generating system is different from a steam generator.

2. List two ways it is similar to a steam generator.

Assessment Activity Writing Prompt:

You know a lot about the three types of power plants and how they generate electricity. Now, make a brochure to inform your classmates how the three types of power plants generate electricity.

Before you begin the brochure, think about how each type of plant produces energy to turn the turbines, what types of fuels are used and the major differences between the three.

How is Electricity Produced?
2.2 Power Plants in Maryland

Activity A: Locating Power Plants

When you turn on a light switch at school or in your home, electrical power is coming from somewhere to enable you to have light. Can you locate the power plant closest to your school or home? What kind of fuel does it use?

In this activity, you will locate various power plants in Maryland and identify nearby power plants that could supply electricity to your school. *This electricity can come from power plants anywhere in Maryland or from other nearby states.*

Materials:

Blank map of Maryland that illustrates the counties (Supplement A)

A copy of "Power Plant Locations In and Around Maryland" (Supplement B)*

Table 1: Major Utilities and Power Plants in Maryland in Activity B*

Colored pencils/markers

Reference maps (an atlas or a Maryland road map)

*For the most recent information, visit the Maryland Power Plant Research Program Online Energy Fact Book http://esm.versar.com/pprp/factbook/plantlocations.htm

Procedure:

1. Set aside space on your map to create a legend. Make a symbol for each new feature you add to your map and include it in the legend. Use different colored pencils for different features. Use an atlas or Maryland road map for reference.

2. Devise a directional symbol to indicate north, south, east and west.

3. Locate and label the following major cities: Annapolis, Baltimore and Washington, D.C.

4. Locate and label these major waterways in Maryland: Chesapeake Bay, Susquehanna River, Patuxent River, Choptank River, Potomac River and any waterway closest to your school.

5. Locate, outline and label the county in which your school is located.

6. Locate and label the approximate location of your school.

7. Use the “Power Plant Locations In and Around Maryland” reference map to locate the three power plants closest to your school. Using a symbol of your choice, plot the three power plants on your own map.

8. In your legend, name the three power plants.

9. Locate and label on your map the only nuclear power plant in Maryland.

10. Locate and label on your map a hydroelectric power plant.

11. Construct a chart that will show the three power plants nearest your school and the type of fuel used in each plant.

Use Table 1: Major Utilities and Power Plants in Maryland in Activity B.

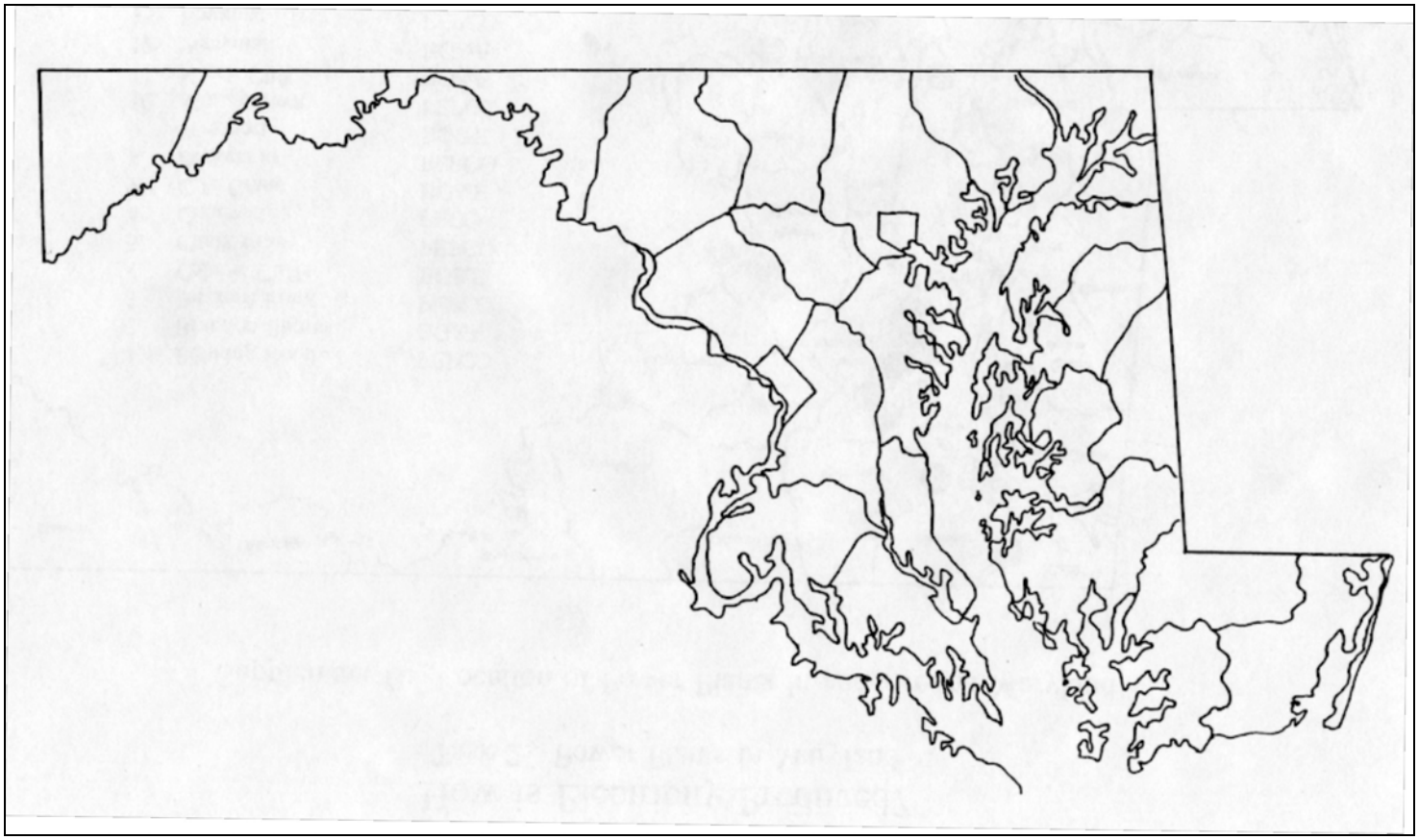
12. Discuss with a partner (*Think-Pair-Share*) the following statements and then report back to the group:

- ❖ Pros and cons of living near a power plant.
- ❖ Pros and cons of living far away from a power plant.
- ❖ The relationship between waterways and power plants.

How is Electricity Produced?

2.2 Power Plants in Maryland

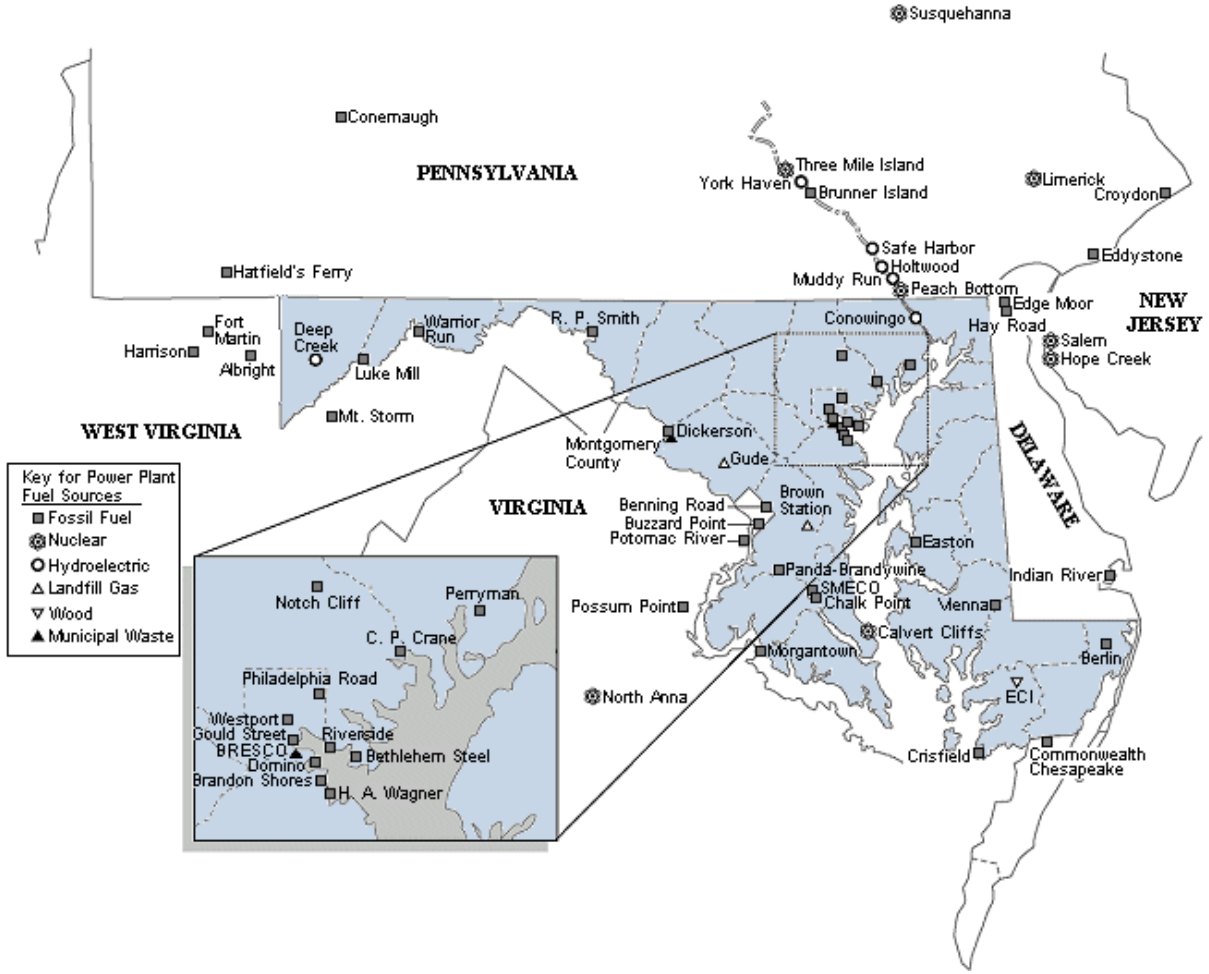
Supplement A: Map of Maryland



How is Electricity Produced?

2.2 Power Plants in Maryland

Supplement B: Location of Power Plants In and Around Maryland



For an up to date map, visit the Online Energy Fact Book : http://esm.versar.com/pprp/factbook/plantlocations.htm

How is Electricity Produced?
2.2 Power Plants in Maryland

Activity B: Power Plants and Types of Fuel

Many power plants in Maryland use a variety of fuels to generate electricity. You are preparing a presentation on the types of fuel used for generating electricity in Maryland and the country. You will need to make a simple graph and display some numbers and percentages so it can be easily understood.

Materials:

Table 1 "Major Utilities and Power Plants in Maryland

Graph Paper

Procedure:

1. Your graph should show what percent of the following fuels is used to generate electricity in Maryland. Your first task is to choose, construct and label a graph that will illustrate the following numbers (You will need to make calculations from the "current capacity" data presented in Table 1: "Major Utilities and Power Plants in Maryland.").

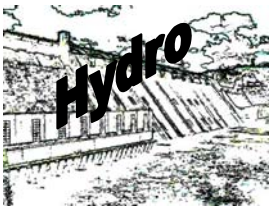
Coal	_____%	Gas	_____%	Nuclear	_____%
Dual Fired	_____%	Hydroelectric	_____%	Petroleum	_____%
Other	_____%				

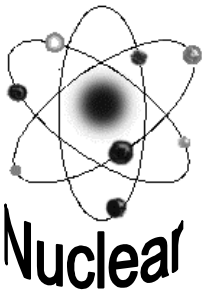
2. Your second task is to graph the percentage of fuel used to generate electricity in the United States. For your second task, use the following numbers:

Coal	35 %	Gas	36 %	Nuclear	11 %
Dual Fired	18. %	Hydroelectric	10 %	Petroleum	7 %
Other	2 %				

3. Now present the information to your class.

Graph Labels:





How is Electricity Produced?

2.2 Power Plants in Maryland

Table 1: Utilities and Power Plants in Maryland

Utility	Plant Name	Major Fuel Type	Current Capacity (Megawatts)
Large Utility Companies			
Allegheny Energy Supply	R.P. Smith	Coal	110
Connectiv Energy Supply	Crisfield	Petroleum	12
Constellation Nuclear	Calvert Cliffs	Nuclear	1721
Constellation Generation Group	Brandon Shores	Coal	1370
	Calvert Cliffs	Nuclear	1829
	C.P. Crane	Coal	397
		Petroleum	16
	Gould Street	Petroleum (Dual)	104
	Notch Cliff	Gas	144
	Perryman	Gas	348
		Petroleum	212
		Petroleum (Dual)	192
	Riverside	Gas	72
		Petroleum	50
		Petroleum (Dual)	122
	H.A. Wagner	Coal	495
		Petroleum (Dual)	548
		Petroleum	16
	Westport	Natural Gas	122
	Philadelphia Road	Petroleum	83
		Subtotal	7963

Independent Power Producers

Utility	Plant Name	Major Fuel Type	Current Capacity (Megawatts)
AES Enterprise	Warrior Run	Coal	229
BRESCO	BRESCO	Waste	65
Exelon Generating Company	Conowingo	Hydroelectric	474
Mirant	Chalk Point	Coal	728
		Petroleum (Dual)	1318
		Petroleum	51
		Gas (Dual)	550
	Dickerson	Coal	588
		Petroleum (Dual)	326
		Petroleum	16
	Morgantown	Coal	1252
		Petroleum	296
Montgomery County	Resource Recovery Facility Gude Landfill	Waste	68
	Gude Landfill	Landfill Gas	3
NRG Energy	Vienna	Petroleum	183
Panda Energy	Brandywine	Gas	21
		Gas (Dual)	197
Prince George's County	Brown Station Road Landfill	Landfill Gas	6
Reliant Energy	Deep Creek Lake	Hydroelectric	20
		Subtotal	6391

Cooperating and Municipal Utilities

Utility	Plant Name	Major Fuel Type	Current Capacity (Megawatts)
Berlin	Berlin	Petroleum	9
Easton Utilities	Easton	Petroleum	40
		Petroleum (Dual)	21
ODEC/Con Ed	Rock Springs	Gas	340
Southern MD Energy Co	SMECO	Gas	84
		Subtotal	494

Self-Generators

American Sugar Refining Company	Domino Sugar	Gas (Dual)	18
Bethlehem Steel	Bethlehem Steel	Gas	120
MD Department of Public Safety & Corrections	Eastern Correctional Institutional Cogeneration Facility	Wood	3
		Petroleum	2
Millennium Inorganic Chemicals Inc.	Millennium Hawkins Point	Gas (Dual)	9
		Gas	24
National Institutes of Health	NIH	Gas	23
Sweetheart Cup	Sweetheart Cup	Gas	11
University of Maryland	University of Maryland College Park	Gas (Dual)	27
Westvaco	Luke Mill	Coal	65
		Subtotal	302

How is Electricity Produced?
2.3 Electrical Power, From Power Plant to YOU!

When you flick on a light switch or turn on an appliance, do you ever wonder where the electricity comes from and how it gets to your home?

Materials:

Glue	Large Paper
Scissors	Power Captions for *Delivering Power*

Procedure:

1. Read the story “Delivering the Power”.

2. Identify and discuss the sequence of how electricity gets to your home from the power plant.

3. Create a picture-caption story by cutting out pictures from “Power Captions” and arrange them in a way that best fits the story. Then glue or tape them to a large piece of paper.

4. Write captions that summarize underneath each illustration. Captions should be in complete sentences.

Today's electric power industry is in the business of making electricity and getting it to millions of businesses, schools and homes. Here is how it is done.

Electricity is made in a **generator** at the power plant. The electrical current leaves the generator and travels through the wires all the way to your home. The current produced at the power plant is at high voltage. Voltage is how much push the electricity has. First the voltage is made higher so it can travel through the wires better and for a longer distance. Devices that change electricity along the way by pushing up the voltage or lowering the voltage are called **transformers.**

As the current leaves the power plant, it first goes to a step-up transformer station. From the transformer, the electricity is carried by **transmission lines.** These lines are usually very high off the ground and carry tremendous power. Eventually, the transmission lines lead to a substation transformer. The current is stepped down to a lower voltage for use by local areas.

Distribution lines carry the electricity from the local **substation** transformer to your neighborhood. These lines are often underground and you would find a **transformer box** near your home. Transformers can also be located at the tops of utility poles. If you have a **pole transformer**, you can see the wires going directly to your house. Both types of transformers reduce the voltage again so it can be used safely in your home. Another distribution line carries the electricity from your neighborhood pole transformer into your home. The electricity goes into an **electrical panel box** and then to the wires that lead to **light switches and plug outlets.** As the electricity goes into your home, it passes through an **electrical meter**. This measures the electricity you use in your home and is used to calculate your electricity bill.

Power Captions for *Delivering Power*
(Please cut out)